

Amendments to the Claims

Claim 1 (**Currently Amended**) A microphone device which detects a target sound coming from a direction of the target sound, the microphone device comprising:

a signal generating section for generating a main signal indicative of a result obtained through detection with a sensitivity in the direction of the target sound and a noise reference signal indicative of a result obtained through detection with a sensitivity higher in another direction than in the direction of the target sound by orienting a direction of minimum sensitivity to the direction of the target sound;

a determining section for determining whether a level ratio indicative of a ratio of a level of the main signal to a level of the noise reference signal generated by the signal generating section is larger than a predetermined value;

an adaptive filter section including an adaptive filter, the adaptive filter section for generating a signal indicative of a signal component of the target sound included in the noise reference signal generated by the signal generating section by performing, ~~by an~~ the ~~adaptive filter included in the adaptive filter section,~~ a filtering process on the main signal generated by the signal generating section, and for learning a filter coefficient only when the determining section determines that the level ratio is larger than the predetermined value;

a subtracting section for canceling a signal component of the target sound included in the noise reference signal by subtracting the signal generated by the adaptive filter section from the noise reference signal generated by the signal generating section; and

a noise suppressing section for suppressing a signal component of noise included in the main signal by using the main signal and the noise reference signal after subtraction by the subtracting section, wherein

the noise suppressing section includes:

a noise suppression filter coefficient calculating section for calculating, based on a power spectrum of the main signal and a power spectrum of the noise reference signal after subtraction by the subtraction section, a filter coefficient of a noise suppression filter for suppressing the signal component of the noise included in the main signal; and

a time-variant coefficient filter section for causing the main signal to be subjected to a

filtering process at the noise suppression filter by reflecting the filter coefficient calculated by the noise suppression filter coefficient calculation section.

Claim 2 (**Currently Amended**) The microphone device according to claim 1, wherein the signal generating section includes:

a first microphone unit ~~being placed~~ positioned so that a main axis of directivity is oriented to the direction of the target sound; and

a second microphone unit ~~being placed~~ positioned so that ~~a minimum sensitivity axis~~ a direction of minimum sensitivity of directivity is oriented to the direction of the target sound, wherein

a signal output from the first microphone unit is the main signal and a signal output from the second microphone unit is the noise reference signal.

Claim 3 (**Original**) The microphone device according to claim 1, further comprising

a signal delaying section, being provided between an output end of the noise reference signal in the signal generating section and the subtracting section, for delaying the noise reference signal so as to satisfy conditions of convergence of the adaptive filter of the adaptive filter section.

Claim 4 (**Original**) The microphone device according to claim 1, wherein the predetermined value is changeable.

Claim 5 (**Currently Amended**) The microphone device according to claim 1, wherein the signal generating section includes:

a first microphone unit;

a second microphone unit having a characteristic identical to a characteristic of the first microphone unit;

a delaying section for outputting a signal output from the first microphone unit as being delayed by a predetermined delay amount;

an amplifying section for amplifying the signal output from the delay section;

a first subtracting section for subtracting the signal amplified by the amplifying

section from a signal output from the second microphone unit to generate the main signal; and
a second subtracting section for subtracting the signal output from the delaying section from the signal output from the second microphone unit to generate the noise reference signal, wherein

~~the predetermined delay amount is set so that the noise reference signal includes components of a sound coming from a direction other than the direction of the target sound more than components of the target sound~~ a direction of minimum sensitivity of a directivity of the noise reference signal and a direction of minimum sensitivity of a directivity of the main signal are both directed to approximately the direction of the target sound, and

~~an amplification factor in the amplifying section is set so as to cause a difference in a sensitivity to the target sound between the main signal and the noise reference signal that the sensitivity of the main signal is higher than the sensitivity of the noise reference signal in the direction of the target sound.~~

Claim 6 (Currently Amended) The microphone device according to claim 5, further comprising a setting section for changing the predetermined delay amount used in the ~~delay~~ delaying section.

Claim 7 (Currently Amended) The microphone device according to claim 1, wherein the signal generating section includes:

a first microphone unit;

a second microphone unit having a characteristic identical to a characteristic of the first microphone unit; and

a combining section for generating, based on signals output from the first and second microphone ~~unit, units,~~ the main signal with the sensitivity in the direction of the target sound, and generating a noise signal with minimum sensitivity in the direction of the target sound.

Claim 8 (Withdrawn - Currently Amended) The microphone device according to claim 1, wherein the signal generating section includes:

a first microphone unit;

a second microphone unit ~~being placed~~ positioned so that a main axis of directivity is oriented to a direction which is different from a main axis of directivity of the first microphone unit;
a signal adding section for adding a first signal output from the first microphone unit and a second signal output from the second microphone unit to generate the main signal; and
a signal subtracting section for subtracting a third signal, which is either one of the first signal and the second signal, from a fourth signal, which is either one of the first signal and the second signal but other than the third signal, to generate the noise reference signal.

Claim 9 (Withdrawn) The microphone device according to claim 1, wherein
the signal generating section includes:

a first microphone unit;
a second microphone unit having a characteristic identical to a characteristic of the first microphone unit;
a stereo signal generating section for generating, based on the first and second microphone units, a stereo signal formed by a right channel signal and a left channel signal;
an inverse combining section for generating, based on the stereo signal, signals output from the first and second microphone units; and
a combining section for generating the main signal and the noise reference signal based on the signals generated by the inverse combining section.

Claim 10 (Withdrawn) The microphone device according to claim 1, wherein
the signal generating section includes:

a first microphone unit;
a second microphone unit having a characteristic identical to a characteristic of the first microphone unit;
a stereo signal generating section for generating, based on the first and second microphone units, a stereo signal formed by a right channel signal and a left channel signal;
a signal adding section for adding the right channel signal and the left channel signal to generate the main signal; and
a signal subtracting section for subtracting a first signal, which is either one of the

right channel signal and the left channel signal, from a second signal, which is either one of the right channel signal and the left channel signal but other than the first signal, to generate the noise reference signal.

Claim 11 (Withdrawn) The microphone device according to claim 1, further comprising:

- a reflection information calculating section for calculating, based on the filter coefficient of the adaptive filter section, information about a difference in arrival time between a direct wave of the target sound and a reflected wave of the target sound; and

- a reflection correcting section for correcting, based on the information calculated by the reflection information calculating section, distortion in a frequency characteristic of the main signal caused by the reflected wave, wherein

- the noise suppressing section suppresses the signal component of the noise included in the main signal by using the main signal corrected by the reflection correcting section and the noise reference signal after subtraction by the subtracting section.

Claim 12 (Canceled)

Claim 13 (Currently Amended) The microphone device according to claim ~~12~~, 1, wherein

- the noise suppression filter coefficient calculating section includes:

- a first frequency analyzing section for calculating ~~a~~ the power spectrum of the main signal:

- a second frequency analyzing section for calculating ~~a~~ the power spectrum of the noise reference signal after subtraction by the subtracting section;

- a power spectrum ratio calculating section for calculating a time average of a power spectrum ratio between the power spectrum calculated by the first frequency analyzing section and the power spectrum calculated by the second frequency analyzing section only when the determining section determines that the level ratio is smaller than the predetermined value;

- a multiplying section for multiplying the time average of the power spectrum ratio calculated by the power spectrum ratio calculating section by the power spectrum calculated by the second frequency analyzing section; and

a coefficient calculating section for calculating the filter coefficient of the noise suppression filter based on the power spectrum calculated by the first frequency analyzing section and the multiplication result of the multiplying section.

Claim 14 (Currently Amended) A microphone device which detects a target sound coming from a direction of the target sound, the microphone device comprising:

a signal generating section for generating a main signal indicative of a result obtained through detection with a sensitivity in the direction of the target sound and a noise reference signal indicative of a result obtained through detection with a sensitivity higher in another direction than in the direction of the target sound by orienting a direction of minimum sensitivity to the direction of the target sound;

a determining section for determining whether a level ratio indicative of a ratio of a level of the main signal to a level of the noise reference signal generated by the signal generating section is larger than a predetermined value;

an adaptive filter section including an adaptive filter, the adaptive filter section for generating a signal indicative of a signal component of the target sound included in the noise reference signal generated by the signal generating section by subjecting the main signal generated by the signal generating section to a filtering process at ~~an~~ the adaptive filter ~~included in the adaptive filter section~~, and for learning a filter coefficient only when the determining section determines that the level ratio is larger than the predetermined value;

a subtracting section for canceling a signal component of the target sound included in the noise reference signal by subtracting the signal generated by the adaptive filter section from the noise reference signal generated by the signal generating section;

a reflection information calculating section for calculating information about a difference in arrival time between a direct wave of the target sound and a reflected wave of the target sound; and

a reflection correcting section for correcting, based on the information calculated by the reflection information calculating section, distortion in a frequency characteristic of the main signal caused by the reflected wave.

Claim 15 (**Currently Amended**) The microphone device according to claim 14, wherein the signal generating section includes:

a first microphone unit ~~being placed~~ positioned so that a main axis of directivity is oriented to the direction of the target sound; and

a second microphone unit ~~being placed~~ positioned so that ~~a minimum sensitivity axis~~ a direction of minimum sensitivity of directivity is oriented to the direction of the target sound, wherein

a signal output from the first microphone unit is the main signal and a signal output from the second microphone unit is the noise reference signal.

Claim 16 (**Original**) The microphone device according to claim 14, further comprising

a signal delay section, being provided between an output end of the noise reference signal in the signal generating section and the subtracting section, for delaying the noise reference signal so as to satisfy conditions of convergence of the adaptive filter of the adaptive filter section.

Claim 17 (**Original**) The microphone device according to claim 14, wherein the predetermined value is changeable.

Claim 18 (**Currently Amended**) The microphone device according to claim 14, wherein the signal generating section includes:

a first microphone unit;

a second microphone unit having a characteristic identical to a characteristic of the first microphone unit;

a delaying section for outputting a signal output from the first microphone unit as being delayed by a predetermined delay amount;

an amplifying section for amplifying the signal output from the delay section;

a first subtracting section for subtracting the signal amplified by the amplifying section from a signal output from the second microphone unit to generate the main signal; and

a second subtracting section for subtracting the signal output from the delaying section from the signal output from the second microphone unit to generate the noise reference

signal, wherein

the predetermined delay amount is set so that ~~the noise reference signal includes components of a sound coming from a direction other than the direction of the target sound more than components of the target sound~~ a direction of minimum sensitivity of a directivity of the noise reference signal and a direction of minimum sensitivity of a directivity of the main signal are both directed to approximately the direction of the target sound, and

an amplification factor in the amplifying section is set ~~so as to cause a difference in a sensitivity to the target sound between the main signal and the noise reference signal~~ that the sensitivity of the main signal is higher than the sensitivity of the noise reference signal in the direction of the target sound.

Claim 19 (Currently Amended) The microphone device according to claim 18, further comprising a setting section for changing the predetermined delay amount used in the ~~delay~~ delaying section.

Claim 20 (Currently Amended) The microphone device according to claim 14, wherein

the signal generating section includes:

a first microphone unit;

a second microphone unit having a characteristic identical to a characteristic of the first microphone unit; and

a combining section for generating, based on signals output from the first and second microphone ~~unit, units,~~ the main signal with the sensitivity in the direction of the target sound, and generating a noise signal with minimum sensitivity in the direction of the target sound.

Claim 21 (Withdrawn – Currently Amended) The microphone device according to claim 14, wherein

the signal generating section includes:

a first microphone unit;

a second microphone unit ~~being placed~~ positioned so that a main axis of directivity is oriented to a direction which is different from a main axis of directivity of the first microphone unit;

a signal adding section for adding a first signal output from the first microphone unit and a second signal output from the second microphone unit to generate the main signal; and

a signal subtracting section for subtracting a third signal, which is either one of the first signal and the second signal, from a fourth signal, which is either one of the first signal and the second signal but other than the third signal, to generate a noise reference signal.

Claim 22 (Withdrawn) The microphone device according to claim 14, wherein

the signal generating section includes:

a first microphone unit;

a second microphone unit having a characteristic identical to a characteristic of the first microphone unit;

a stereo signal generating section for generating, based on the first and second microphone units, a stereo signal formed by a right channel signal and a left channel signal;

an inverse combining section for generating, based on the stereo signal, signals output from the first and second microphone units; and

a combining section for generating the main signal and the noise reference signal based on the signals generated by the inverse combining section.

Claim 23 (Withdrawn) The microphone device according to claim 14, wherein

the signal generating section includes:

a first microphone unit;

a second microphone unit having a characteristic identical to a characteristic of the first microphone unit;

a stereo signal generating section for generating, based on the first and second microphone units, a stereo signal formed by a right channel signal and a left channel signal;

a signal adding section for adding the right channel signal and the left channel signal to generate a main signal; and

a signal subtracting section for subtracting a first signal, which is either one of the right channel signal and the left channel signal, from a second signal, which is either one of the right channel signal and the left channel signal but other than the first signal, to generate a noise reference

signal.

Claims 24-26 (Canceled)

Claim 27 (Currently Amended) An audio ~~player~~, player comprising:

an audio recording section for recording audio signals of channels of at least two types;

a signal generating section for generating, based on the audio signals recorded on the audio recording section, a main signal indicative of a result obtained through detection with a sensitivity in the direction of the target sound and a noise reference signal indicative of a result obtained through detection with a sensitivity higher in another direction than in the direction of the target sound by orienting a direction of minimum sensitivity to the direction of the target sound;

a determining section for determining whether a level ratio indicative of a ratio of a level of the main signal to a level of the noise reference signal generated by the signal generating section is larger than a predetermined value;

an adaptive filter section including an adaptive filter, the adaptive filter section for generating a signal indicative of a signal component of the target sound included in the noise reference signal generated by the signal generating section by performing, ~~by an~~ the adaptive filter ~~included in the adaptive filter section~~, a filtering process on the main signal generated by the signal generating section, and for learning a filter coefficient only when the determining section determines that the level ratio is larger than the predetermined value;

a subtracting section for canceling a signal component of the target sound included in the noise reference signal by subtracting the signal generated by the adaptive filter section from the noise reference signal generated by the signal generating section;

a noise suppressing section for suppressing a signal component of noise included in the main signal by using the main signal and the noise reference signal after subtraction by the subtracting section; and

a reproducing section for reproducing the main signal with the signal component of the noise being suppressed by the noise suppressing section, wherein

the noise suppressing section includes:

a noise suppression filter coefficient calculating section for calculating, based on a

power spectrum of the main signal and a power spectrum of the noise reference signal after subtraction by the subtraction section, a filter coefficient of a noise suppression filter for suppressing the signal component of the noise included in the main signal; and
a time-variant coefficient filter section for causing the main signal to be subjected to a filtering process at the noise suppression filter by reflecting the filter coefficient calculated by the noise suppression filter coefficient calculation section.

Claim 28 (Currently Amended) The audio player according to claim 27, further comprising:

a video recording section for recording a video signal related to the audio signals recorded on the audio recording section;

a video reproducing section for reproducing the video signal recorded on the video recording section; and

a direction accepting section for accepting from a user an input of a direction in which a sound is to be ~~enhanced~~; enhanced, wherein

the signal generating section generates the main signal and the noise reference signal by taking the direction accepted by the direction accepting section as the direction of the target sound.